TERRESTRIAL Abstracts

Back to Session Profile

Click here to collaborate

Novel Calibration Systems for Mercury Measurement Research
Winston Luke (OAR/ARL)
Remote Sensing of Streams for Discharge Estimation
Jonathan Gourley (OAR/NSSL)
A New Ground-based Snow-level Radar
Allen White (OAR/ESRL)
A Ground-based Network of Boundary Layer Profilers
Dave Turner (OAR /NSSL)
Traffic Cameras Analytics in the National Mesonet Program
Curtis Marshall (NWS/OBS)

Novel Calibration Systems for Mercury Measurement Research

Winston Luke (OAR/ARL)

Mercury is a potent toxin which adversely affects neurological functioning and development, especially in infants and young children. Human exposure to mercury arises primarily through the consumption of contaminated seafood, and the dominant source of mercury input to aquatic ecosystems is the deposition of mercury emitted to the atmosphere, primarily through coal combustion, incineration, and various industrial processes. Accurate measurements of atmospheric mercury compounds are crucial to our understanding of the chemical and physical dynamics of mercury cycling in the wider environment. However, current atmospheric measurement methods are subject to considerable biases and artifacts under certain conditions. Staff from the Air Resources Laboratory are developing methods to more accurately characterize the accuracy and precision of atmospheric mercury measurements, with the goal of making these improvements available to the scientific community in partnership with commercial vendors.

Early successes: Extensive laboratory tests and emerging results of field tests and deployments at our Beltsville, MD site in the Atmospheric Mercury Network (AMNet) show considerable promise of the calibration systems' ability to better quantify current measurement uncertainties. Prototypes of our standard addition system for gaseous elemental mercury have been constructed and will be deployed at our field site at the Mauna Loa Observatory on the Island of Hawaii. In addition, scientists from Environment Canada have expressed interest in deploying such a system at their observing station at Alert, in the Qikiqtaaluk Region, Nunavut, Canada (latitude 82°30'05" north), 817 kilometers from the North Pole. The system will be deployed at all three sites over a one year period to assess measurement performance at high altitude (Mauna Loa) and at a location in the Arctic which is subject to unique chemical cycling processes in the atmospheric mercury cycle during the Polar Spring.

Anticipated Impacts: Successful development and deployment of these novel calibration methods may dramatically improve the quality of atmospheric mercury measurements around the globe, and transform our understanding of mercury in the atmosphere, its distribution, and the chemical processes controlling its fate. Only one commercial chemical monitor is capable of adequately measuring the dominant forms of atmospheric mercury, and although the measurement method does suffer from potential biases and artifacts, the instrumentation sees wide deployment in the U.S. and around the world. Although emissions reductions in North America and throughout Europe have contributed to local and regional decreases in atmospheric mercury concentrations, hotspots of increased mercury emission in China, India, and Western Africa threaten to increase levels of this global pollutant. Mercury's harmful effects on human and ecosystem health are therefore likely to grow in the future, necessitating our ability to more accurately measure it in the atmosphere.

Remote Sensing of Streams for Discharge Estimation

Jonathan Gourley (OAR/NSSL)

This study describes a potential solution to discharge estimation that relies entirely on remote sensing measurements and does not require rating curves. The system uses off-the-shelf K-band radars for retrieving the stage height of the stream and the surface velocity. NSSL engineers have developed a scanning lidar system that is capable of retrieving the channel bathymetry by penetrating the water column. The system has been tested in Waldo Canyon, Colorado with promising initial results. Limitations to the bathymetric retrievals include conditions with significant turbidity and surface disturbances such as bubbles.

Early successes: The prototype scanning lidar was attached to the K band stream radar system and deployed over a stream in Waldo Canyon, CO. This is a USGS test basin that has been impacted by wildfire in 2012 and subsequent debris flow events in 2013. Early results showed that the scanning lidar successfully detected the bottom of the stream during low turbidity conditions. Turbidity increased following a rain storm, which limited the ability to penetrate the water column.

Anticipated Impacts: NOAA's new National Water Model will increase the number of river forecast points up to 2.67 million. The United States Geological Survey (USGS) operates and maintains over 7000 streamgages across the U.S. These observations serve as a critical network to inform hydrologic simulations and to improve the forecasts by assimilating the data into the NWM. USGS streamgages nominally measure the stage of rivers using a float in a stilling well, a pressure transducer, or stage radar. In order to estimate the discharge of the river from the stage measurements, a stage-discharge relationship must be established through the development of a rating curve. These rating curves require manual, in-situ measurements over a wide range of river flow conditions and must be updated in response to changes in the channel bed bathymetry. As a result, the annual operating and maintenance costs of a traditional streamgage are similar to the initial cost of the instrument. Non-contact continuous-wave (CW) radar platforms coupled with an efficient computational scheme offers a relatively inexpensive solution to expand the existing network of discharge measurements. The scanning lidar coupled with the stream radar platforms provides the capability to retrieve the channel bathymetry. When combined with the stream radar measurements, stream discharge can be calculated from the velocity, stage height, and cross-sectional area measurements. All of these variables are measured using remote-sensing methods. The non-contact measurements are less susceptible to being lost during a flood and the combination of the measurements negates the need to establish and maintain costly rating curves.

A New Ground-based Snow-level Radar

Allen White (OAR/ESRL)

PSD and CIRES engineers at the Earth System Research Laboratory have designed and built a frequency-modulated, continuous-wave (FM-CW) profiling radar (Snow-level radar) that operates in the S-band frequency range. This instrument provides vertical profiles of radar reflectivity and Doppler vertical velocity from which the snow level (i.e., the level in the atmosphere where snow changes into rain) is retrieved during precipitation using a patented automated algorithm. The Snow-level radar is much less expensive than traditional pulsed radar systems because it uses the FM-CW technology and commercial off-the-shelf components. The snow level is an important variable for hydrometeorology, transportation, recreation and other applications. NWS forecasters currently rely on numerical weather prediction models to provide this information, however research has shown that these models often have large biases in some storms, especially warm events that can have adverse hydrometeorological impacts in mountainous regions.

Early successes: The snow-level algorithm that is used with the Snow-level radar was first developed at the request of NWS forecasters during the Pacific Land-falling Jets Experiment (PACJET). NOAA's Hydrometeorology Testbed (HMT; hmt.noaa.gov) began providing snow-level measurements routinely using PSD's array of pulsed profiling radars in the early 2000's. Some of these radars are now commercially available through Scintec, AG, and the algorithm has been incorporated into the commercially available LAPXM profiler operating software. HMT engineers designed the Snow-level radar to be a low-cost alternative to the other radars that PSD operates. Through a cooperative agreement with the California Department of Water Resources, a ten-station network of Snow-level radars has been installed in major watersheds across the state. Data from the network are transmitted to NWS Western Region through LDM. The Snow-level radars have also been used successfully in the HMT Southeast Pilot Study and in an HMT-sponsored project at Plymouth State University in New Hampshire.

Anticipated Impacts: The main impacts of this technology will be for the NWS Watch/Warning Program related to wintertime weather. For example, forecasters will be able to adjust a Winter Storm Warning based on information provided by the snow-level radar. PSD collocates a surface weather station with each Snow-level radar, so the radars are also adept at detecting icing conditions, for example, that were prevalent in the Northeast U.S. this past winter season. This information will also be valuable to transportation departments to determine the extent to which snow removal equipment needs to be deployed.

A Ground-based Network of Boundary Layer Profilers

Dave Turner (OAR /NSSL)

Several high-level reports (e.g., from the National Research Council and the National Weather Service) have specified the need for high temporal resolution temperature, humidity, and wind profiles in the atmospheric boundary layer (i.e., the lowest few kilometers of the troposphere) across the continental U.S. A network of these observations, which may include up to 400 stations, would be useful for improving short-term and longer-term weather forecasts of significant weather events (e.g., convection initiation, severe weather and precipitation, winter storms), air quality forecasting, fire weather forecasting, and to aid decision making in the transportation, agriculture, and homeland security areas. Due to the high temporal and vertical resolution requirements, these observations would need to be made with ground-based remote sensors, as satellite sensors do not have the required sensitivity in the boundary layer (and the boundary layer is often obscured by clouds), surface sensors do not have the vertical information, and aircraft-based in-situ observations are too sporadic in time and location. There are several ground-based remote sensing systems that can be leveraged by NOAA to provide high-temporal (better than 5-minute) resolution profiles of a wide range of variables. These systems are kilometers, microwave radiometers, Doppler lidars, infrared spectrometers, and UHF radar wind profilers. All of these remote sensing systems are very mature, have been used by the research and/or operational communities for over a decade, have played an important role in NOAA-sponsored research projects during this time, are commercially available, and have relatively small footprints. The measurements made by these instruments would provide critically important observations to NWS operational weather forecasting models, greatly improving the accuracy of the analysis used as the basis of the numerical forecast. An Observation System Simulation Experiment (OSSE) demonstrated that a network of 140 stations equipped with infrared spectrometers and Doppler lidars greatly improved the forecasted timing, location, and intensity of synoptically-forced convective precipitation. However, additional studies (including OSSEs) need to be conducted to evaluate different deployment strategies and to find an optimal station density for a range of different applications.

Early successes: All of the instruments being considered here are either already part of an operational network (such as the ceilometers which part of the NWS automated surface observation systems but the full capability of the system isn't being used) or have been used for long-term field experiments by different NOAA / OAR laboratories. As an example, all of these ground based profilers were successfully deployed in the 2015 Plains Elevated Convection and Night (PECAN) field experiment.

PECAN was a 6-week field experiment in June-July 2015, and operated 10 integrated profiling sites (6 fixed, 4 mobile) in a domain that stretched from northern Oklahoma to Nebraska. Data from these instruments offer an unprecedented view of the structure and evolution of the temperature, humidity, winds, and clouds in the lowest 3 km of the atmosphere, and have been used to evaluate/improve numerical weather prediction models, for wind energy studies, and more.

Anticipated Impacts: A network of boundary layer profilers would provide a much better characterization of the vertical structure of the atmospheric boundary layer and how it is evolving. This information would greatly improve the analyses generated by numerical weather prediction models, from which forecasts are based. An Observation System Simulation Experiment (OSSE) has demonstrated that a network of these profiles greatly improved the timing, location, and intensity of the rainfall in a convective precipitation event over the central U.S. Furthermore, the improved analysis of the boundary layer would greatly benefit wind energy prediction forecasts, and would be very beneficial for aviation, transportation, and agriculture. Thus, the primary beneficiary would be the NWS, but other groups within NOAA and other agencies (e.g., FAA) would benefit also.

Traffic Cameras Analytics in the National Mesonet Program

Curtis Marshall (NWS/OBS)

The National Mesonet Program supports the provision of multiple types of observations that are used in NWS forecast operations, including surface meteorological data, ground-based vertical profiling devices of many types, soil moisture, aircraft-based observations, and observations taken with instrument platforms mounted on fleets of commercial delivery vehicles (trucks and vans). Some of these mobile observing platforms include a sensor for measuring light, as a surrogate for visibility in the roadway environment. Recently, a exploratory effort has been underway under the auspices of the program to use this information in conjunction with traffic camera imagery to deduce weather and environmental variables in the roadway environment, including fog, precipitation, and icing. In essence, the traffic camera imagery is used with sophisticated "analytics" to derive proxy environmental observations. These "observations" can be provided to forecasters in NWS offices in real time using complex software packages to increase forecaster situational awareness. This capability is being informally tested in a small ground of Forecast Offices in the NWS Eastern Region. This talk will briefly review the science and technology behind the concept and its potential future applications to NWS operations.

Early successes: Efforts have just begun to test the traffic cam analytics capability and related "observations" in a select group of WFOs in NWS Eastern Region. The results of this informal field test will be available this fall. NWS will take these results into consideration in any planning for expanding the field test to a larger footprint of WFOs and any plans to take it into operations in the longer term.

Anticipated Impacts: The primary service enhancement is to fill in gaps in NWS observing systems at the surface, with a particular focus on environmental parameters having a significant impact on transportation in the roadway environment.

Back to Session Profile